PRV

PATENT- OCH REGISTRERINGSVERKET

Patentavdelningen

Intyg
Certificate

Härmed intygas att bifogade kopior överensstämmer med de handlingar som ursprungligen ingivits till Patent- och registreringsverket i nedannämnda ansökan.

This is to certify that the annexed is a true copy of the documents as originally filed with the Patent- and Registration Office in connection with the following patent application.

(71) Sökande Applicant (s) — *Volvo Penta AB, Göteborg SE*

(21) Patentansökningsnummer Patent application number — *0103812-4*

(86) Ingivningsdatum Date of filing — *2001-11-16*

Stockholm, 2004-06-10

För Patent- och registreringsverket
For the Patent- and Registration Office

Hjördis Segerlund

Hjördis Segerlund

Avgift
Fee 170:-

CERTIFIED COPY OF PRIORITY DOCUMENT

V79 P1SE/BRR
2001-11-15

Remote control system for a vehicle

TECHNICAL FIELD

The present invention relates to a remote control system for a vehicle, and in particular to a remote control system for a water-going craft having multiple independently steerable propulsion drives, such as rotatable thruster assemblies.

BACKGROUND

Remote controls for vehicles are well established and are currently used for controlling a wide span of vehicles, ranging from simple radio-controlled toys to larger vehicles such as trucks, boats and unmanned reconnaissance aircraft.

A remote control unit normally communicates wirelessly with the vehicle, for example by means of radio transmissions or other suitable means such as infra red light. Alternatively, the remote control unit communicates with the vehicle by means of a communication wire.

In the marine sector, the use of multiple independently steerable propulsion drives now extends not only to larger ships, offshore platforms and the like, but also to yachts and smaller boats where an increased maneuverability compared to conventional fixed-drive/rudder combinations or conventional stern drives is desirable. The coordination of steering and thrust of the independently steerable propulsion drives in order to execute a desired maneuver is generally managed by an onboard steering computer. Here, the use of a remote control system for communicating with the steering computer allows the user or helmsman to move about freely aboard the boat into optimum vantage positions for various maneuvers. For example, the user or

helmsman may conveniently stand near the stem or bow of the boat - whichever the case may be - in order to gently maneuver the boat alongside a dock or jetty whilst maintaining a close overview of the boat movement.

A well known problem with current remote control systems is, however, that the relative orientation of the controls only coincides with the "normal" orientation of the fixed primary controls of the boat as long as the remote control unit is aligned with the stern-to-bow direction of the boat. As soon as this is no longer the case, the user or helmsman has to mentally convert the desired direction of travel into correct steering commands to the remote control. If, for example, the user or helmsman is facing backwards towards the stern of the boat, the correct steering commands to enter into the remote control unit becomes a mirror image of the normal commands to which the user or helmsman is accustomed. This problem is common to known remote controls of the above-described type and is often a contributing cause of maneuvering errors, especially for inexperienced users.

SUMMARY OF THE INVENTION

The above mentioned problem is solved by a remote control system for a vehicle, comprising

- a primary heading sensor fixedly attached to the vehicle, said primary heading sensor being adapted to detect a reference heading;
- a remote control unit comprising a steering input manipulator, said remote control unit being either portable by a user or rotationally attached to the vehicle relative to a main axis of the vehicle, the remote control unit being adapted to communicate steering input data to
- a steering computer programmed to process the steering input data into steering commands and to communicate the steering commands to a steering mechanism of the vehicle,

wherein:

- said remote control unit comprises a secondary heading sensor which is synchronized with said primary heading sensor with respect to said reference heading, and wherein
- said steering input data includes information of an active position of said steering input manipulator relative to the reference heading, said active position of the steering input manipulator determining the desired direction of travel of the vehicle regardless of the orientation of the remote control unit relative to the main axis of the vehicle.

In one embodiment of the invention, the primary and secondary heading sensors each comprises a compass and said reference heading corresponds to - or is otherwise related to - the magnetic north pole.

In a suitable embodiment, the secondary heading sensor comprises a flux gate compass and the steering input manipulator includes a joystick. The steering input data then includes a projected angle between the reference heading and the inclination direction of the joystick.

In one embodiment the steering input data further includes a desired relative thrust value defined by the degree of inclination from a vertical reference position of the joystick.

Advantageously, the secondary heading sensor is continuously synchronized with the primary heading sensor and the remote control unit is adapted for wireless communication with the steering computer.

In a favorable embodiment of the invention, the vehicle is a water-going craft having multiple independently steerable propulsion drives. The steering commands from the steering computer then comprises individually computed thrust and steering angle values for each propulsion drive, needed to move the craft in the desired direction of travel as indicated by the steering input manipulator.

The water-going craft further suitably comprises a bow thruster assembly oriented substantially transversally to the main axis, said bow thruster assembly being directly or indirectly linked to the steering computer.

In a well suited embodiment, the water-going craft also comprises one or more rudders, said rudders being directly or indirectly linked to the steering computer.

In an alternative embodiment, the steering input manipulator includes a substantially spherical tracking-ball. The steering input data then includes an angle between the reference heading and the direction of rotation the tracking-ball. In one related embodiment, the steering input data further includes a desired relative thrust value defined by the degree of rotation from a central reference position of the tracking-ball.

The remote control system according to the invention thus offers a substantial improvement over known systems in that it will cause the vehicle to move in the direction the steering input manipulator is pointing at - or is set to - regardless of the orientation of the remote control unit relative to the main axis of the vehicle. This ensures safe and efficient maneuvering capabilities and eliminates the well known problem of having to mentally convert the desired direction of travel into correct steering commands when the remote control unit is not aligned with the stern-to-bow direction (i.e. said main axis) of the boat.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in greater detail by way of example only and with reference to the attached drawings, in which

fig. 1 is a schematic representation of the remote control system of the invention as applied in a boat equipped with twin independently steerable propulsion drives. Here, the remote control unit is aligned with the stern-to-bow direction of the boat;

fig. 2 is a schematic representation similar to the one shown in fig. 1 except for the remote control unit being out of alignment with the stern-to-bow direction of the boat;

fig. 3 is a schematic representation of a boat additionally provided with rudders and a bow thruster assembly being maneuvered alongside a jetty, the remote control unit being manipulated by a user who is standing on the jetty;

fig. 4 is a simplified perspective image of a remote control unit having a steering input manipulator in the form of a joystick, and finally:

fig. 5 is a simplified perspective image of a remote control unit having a steering input manipulator in the form of a tracking-ball.

DESCRIPTION OF EMBODIMENTS

In fig. 1, an exemplary embodiment of a remote control system according to the invention is shown schematically for the sake of clarity. Reference numeral 1 hereby denotes a vehicle in the form of a boat having a pointed bow 2 and a flat stern 3. The main axis of the boat is defined as a line of

symmetry stretching from the stern 3 to the bow 2, said main axis being denoted by a shortened dashed line with reference numeral 4 in the bow 2 of the boat 1.

The boat 1 is equipped with twin independently steerable propulsion drives 5, 6, each schematically represented by a propeller 7 and an arrow 8 indicating direction of thrust. Each propulsion drive 5, 6 may be fully or partially rotatable about a substantially vertical axes (not shown) in a known manner. Furthermore, the propellers 7 may be of either a pushing design or a pulling design. For slower boats, for example tugs, the propulsion drives 5, 6 may consist of fully rotatable so called tunnel thruster assemblies (not shown) for added thrust effect at slow speed. The engines driving the propulsion drives 5, 6 are not shown in the figures, but may consist of any appropriate marine engine type depending on the operational specification demands on the boat 1.

The propulsion drives 5, 6 in the shown example are communicating with a steering mechanism 9 via mechanical, electrical or wireless links 10, 11. The steering mechanism 9 is further adapted to receive steering commands from an onboard steering computer 12 via a communication link 13. The steering commands also include information of desired general thrust effect level. The steering computer 12 manages the coordination of steering and thrust of the independently steerable propulsion drives 5, 6 in order to execute a desired maneuver.

As shown in fig. 1, the remote control system comprises a primary heading sensor 14 fixedly attached to the boat 1, said primary heading sensor 14 being adapted to detect a reference heading indicated in the figures with an arrow marked with the letter "N". The primary heading sensor 14 communicates with the onboard steering computer 12. In one embodiment of the invention, the primary heading sensor 14 is also the main navigational compass of the boat 1, and the reference heading corresponds to - or is

otherwise related to - the magnetic north pole, as indicated by the arrow marked with the letter "N".

As such, the primary heading sensor or compass 14 may be of varying designs depending on the size and operational use of the boat 1. Hence, larger yachts and ships are normally equipped with a gyroscopic compass, whilst smaller boats 1 are normally equipped with the cheaper conventional magnetic compass.

Furthermore, the remote control system includes a remote control unit 15 which is either portable by a user – as is the case in the shown embodiment - or rotationally attached (not shown) to the boat 1 relative to the main axis 4 of the boat 1. The latter embodiment may for example be applied on the bridge wings (not shown) of larger yachts or ships, where remote control units 14 may be rotationally attached to a fixed stand or pillar (not shown) on said bridge wings, as a complement to the main controls (not shown) of the yacht or ship.

The remote control unit 15 is provided with a steering input manipulator 16, which in the embodiment shown in figs. 1 – 4 has the form of a joystick. By means of the steering input manipulator 16, the remote control unit 15 is adapted for wireless communication of steering input data to the onboard steering computer 12. In the shown example, the wireless communication is transmitted via radio transmissions indicated by the schematically drawn jagged line 17 emanating from a radio antenna 18 on the remote control unit 15 (transmitter and receiver not shown).

A feature of the invention is that the remote control unit 15 further comprises a secondary heading sensor 19 – represented by a small circle in fig. 1 - which is synchronized with the primary heading sensor 14 with respect to said reference heading "N". The steering input data hereby includes information of an active position of the steering input manipulator 16 relative

to the reference heading "N", whereby said active position of the steering input manipulator 16 determines the desired direction of travel of the boat 1 regardless of the orientation of the remote control unit 15 relative to the main axis 4 of the boat 1.

In fig. 1, the remote control unit 15 is oriented in the direction of the main axis 4 of the boat 1, and thus in the same way as the fixedly mounted main controls (not shown) of the boat 1. The viewing direction of the helmsman is in the same direction, as indicated with a schematic eye symbol 20 on the remote control unit 15. Since the reference heading N denotes the magnetic north in the shown example, the boat 1 is oriented in a north-easterly direction, i.e. upwardly and to the right on the drawing sheet. The helmsman now wants to move the boat 1 in a south-easterly direction, and thus moves the joystick 16 in the desired direction of travel, as indicated by the small hollow arrow 21. The remote control unit 15 then sends steering input data to the steering computer 12, including a projected angle α between the reference heading N and the inclination direction of the joystick (i. e. the desired direction of travel, as indicated by the small hollow arrow 21 in figs. 1-3).

The steering computer 12 processes the steering input data into steering commands, which are sent to the steering mechanism 9. The steering commands comprise individually computed thrust and steering angle values for each propulsion drive 5, 6, which are needed to move the boat 1 in the desired direction of travel 21 as indicated by the joystick 16. In consequence, the boat 1 moves in an actual direction of travel indicated by the large hollow arrow 22. Since the secondary heading sensor 19 is continuously synchronized with the primary heading sensor 14, the actual direction of travel 22 will come to coincide with the desired direction of travel 21. In this case, where the remote control unit 15 is oriented in the direction of the main axis 4 of the boat 1, the steering operation will appear to the helmsman like a

fully normal operation as performed with the main, fixed controls (not shown) of the boat 1.

Fig. 2 is very similar to fig. 1, except for the orientation of the remote control unit 15 now being altered so that the unit 15 is no longer aligned with the main axis 4 of the boat 1. The viewing direction 20 of the helmsman is in the same general direction as the remote control unit 15 is pointing at. In order to perform a maneuver identical to that shown in fig. 1, the helmsman again simply moves the joystick 16 in the desired direction of travel 21 and the boat 1 will travel in the same actual direction of travel 22 as in the previous example of fig. 1, i.e. coinciding with the desired direction of travel 21. Thus, according to the invention, the helmsman is no longer forced to mentally recalculate the correct movement of the joystick relative to the orientation of the remote control unit, as is the case with conventional remote control systems. Instead, the boat 1 will simply steer in the direction in which the joystick is pointing – regardless of the orientation of the remote control unit 15 relative to the main axis 4 of the boat 1. This substantially facilitates the maneuvering of the boat.

In fig. 3, a docking situation is shown, in which the helmsman is standing ashore on a dock or jetty 23 with the remote control unit 15, whilst maneuvering the boat 1 towards him and alongside the jetty 23. Again, the helmsman simply points the joystick in the desired direction of travel 21, resulting in the boat 1 moving in an identical actual direction of travel 22 towards the jetty 23. In this way, the helmsman is able to gently pilot the boat 1 alongside the jetty 23 by intuitively performing highly precise maneuvers.

In the embodiment shown in fig. 3, the boat 1 is further provided with a bow thruster assembly 28, a starboard rudder 32 and a port rudder 34. The bow thruster assembly 28 is oriented substantially transversally to the main axis 4 and is directly linked to the steering computer 12 via a communication link 31. In an alternative, not shown embodiment, the bow thruster assembly 28

may be indirectly linked to the steering computer 12 via - for example - the steering mechanism 9.

With further reference to fig. 3, the starboard rudder 32 and the port rudder 34 are directly linked to the steering computer 12 via communication links 33 and 35 respectively. Again, In an alternative, not shown embodiment, the rudders 32 and 34 may be indirectly linked to the steering computer 12 via - for example - the steering mechanism 9.

Fig. 4 shows a simplified perspective image of a remote control unit 15 having a steering input manipulator 16 in the form of a joystick. In a suitable embodiment of the invention, the steering input data includes a desired relative thrust value defined by the degree of inclination from a vertical reference position of the joystick 16. Said vertical reference position is indicated in the figure by the vertical centerline with reference numeral 24.

Fig. 5 finally shows a simplified perspective image of a remote control unit 15 having a steering input manipulator 16 in the form of a spherical so called tracking-ball. The tracking ball 16 is rotatably suspended in an opening 25 in said remote control unit 15. In this embodiment, the steering input data includes an angle β (not shown in the figure, but defined in analogy with the previously described angle α) between the reference heading and the direction of rotation the tracking-ball 16. The direction of rotation is indicated by the dash-dotted line 26 in fig. 5. Advantageously, the steering input data further includes a desired relative thrust value defined by the degree of rotation from a central reference position of the tracking-ball 16. In fig. 5, said central reference position is indicated by the vertical centerline 27.

The secondary heading sensor 19 in the remote control unit 15 is suitably a so called flux gate compass. A general description of such a compass design is given below, without direct reference to any of the drawing figures:

Thus, a flux gate compass is a device in which the balance of currents in coil windings is affected by the Earth's magnetic field. The flux gate compass has two small coils wound on ferrite cores at right-angles to each other. Both are energized in phase at a low frequency usually between 400-1000 Hz. The Earth's magnetic field produces a small phase-shift which depends on the angle of the field relative to the coil. If the field is directly aligned with one coil and therefore directly across the other coil, the coil it is aligned with experiences maximum phase-shift and the other none at all. A small electronic circuit detects the difference and indicates it digitally. Most modern auto-pilot systems rely primarily on the flux gate compass because the response time is substantially shorter than that of a traditional magnetic compass. A flux gate compass is relatively inexpensive, generally very accurate and does not suffer from the problems a mechanical magnetic compass has with vibration and rapid turns.

The primary heading sensor 14 may – as mentioned initially – include a gyroscopic compass. In a gyroscopic compass, the axis of a spinning mass tends to remain pointed in a constant direction. This direction does not necessarily have to be north/south related, since a gyroscopic compass is not north seeking on its own, it has to be calibrated with a conventional or flux gate compass. Thus – in a theoretical alternative embodiment – both the primary and the secondary heading sensors 14, 19 may include gyroscopic compasses. In such an embodiment, it is possible to use a predetermined reference heading which is not related to the magnetic north. For general information, a gyroscopic compass comprises a motor and a heavy disk mounted in a set of gimbals (not shown). Sensors on pivots of the gimbals - or otherwise mounted in the housing of the gyro detect the relative movement between the axis of the gyro and the housing of the gyro.

In an embodiment where one or both of the heading sensors 14, 19 include conventional magnetic compasses, the remote control system will function regardless of the local deviation from true north, since both heading sensors

14, 19 are synchronized with each other with respect to any set reference heading N.

It is to be understood that the invention is by no means limited to the embodiments described above, and may be varied freely within the scope of the appended claims. For example, the remote control unit 15 may alternatively be communicating with the steering computer 12 via a cable (not shown). Further, In an alternative - but not shown embodiment - the boat 1 may be equipped with more than two propulsion drives 5, 6. However, the principle of the invention is also applicable to a boat with a single propulsion drive (not shown). Finally, it should be noted that the remote control system in its broadest sense is applicable to any type of vehicle operating on land, at sea or in the air.

V79 P1SE/BRR
2001-11-15

CLAIMS:

1. Remote control system for a vehicle (1), comprising

- a primary heading sensor (14) fixedly attached to the vehicle (1), said primary heading sensor (14) being adapted to detect a reference heading (N);
- a remote control unit (15) comprising a steering input manipulator (16), said remote control unit (15) being either portable by a user or rotationally attached to the vehicle (1) relative to a main axis (4) of the vehicle (1), the remote control unit (1) being adapted to communicate steering input data to
- a steering computer (12) programmed to process the steering input data into steering commands and to communicate the steering commands to a steering mechanism (9) of the vehicle (1),

characterized in

- that said remote control unit (1) comprises a secondary heading sensor (19) which is synchronized with said primary heading sensor (14) with respect to said reference heading, and in
- that said steering input data includes information of an active position of said steering input manipulator (16) relative to the reference heading (N), said active position of the steering input manipulator (16) determining the desired direction of travel of the vehicle (1) regardless of the orientation of the remote control unit (15) relative to the main axis (4) of the vehicle (1).

2. Remote control system according to claim 1, **characterized in** that said primary and secondary heading sensors (14, 19) each comprises a compass and that said reference heading (N) corresponds to - or is otherwise related to - the magnetic north pole.

3. Remote control system according to claim 2, **characterized in** that the secondary heading sensor (19) comprises a flux gate compass.

4. Remote control system according to any of the preceding claims, **characterized in** that said steering input manipulator (16) includes a joystick.

5. Remote control system according to claim 4, **characterized in** that the steering input data includes a projected angle (α) between the reference heading (N) and the inclination direction of the joystick (16).

6. Remote control system according to claim 5, **characterized in** that the steering input data further includes a desired relative thrust value defined by the degree of inclination from a vertical reference position (24) of the joystick (16).

7. Remote control system according to any of the preceding claims, **characterized in** that the secondary heading sensor (19) is continuously synchronized with the primary heading sensor (14).

8. Remote control system according to any of the preceding claims, **characterized in** that said remote control unit (15) is adapted for wireless communication with the steering computer (12).

9. Remote control system according to any of the preceding claims, **characterized in** that said vehicle (1) is a water-going craft comprising multiple independently steerable propulsion drives (5, 6).

10. Remote control system according to claim 9, **characterized in** that the steering commands from the steering computer (12) comprises individually computed thrust and steering angle values for each propulsion drive (5, 6),

needed to move the craft (1) in the desired direction of travel (21) as indicated by the steering input manipulator (16).

11. Remote control system according to claim 9 or 10, **characterized in** that the water-going craft (1) further comprises a bow thruster assembly (28) oriented substantially transversally to the main axis (4), said bow thruster assembly (28) being directly or indirectly linked to the steering computer (12).

12. Remote control system according to claim 9, 10 or 11, **characterized in** that the water-going craft (1) further comprises one or more rudders (32, 34), said rudders (32, 34) being directly or indirectly linked to the steering computer (12).

13. Remote control system according to any of the preceding claims, **characterized in** that said steering input manipulator (16) includes a substantially spherical tracking-ball.

14. Remote control system according to claim 13, **characterized in** that the steering input data includes an angle (β) between the reference heading (N) and the direction of rotation (26) of the tracking-ball (16).

15. Remote control system according to claim 14, **characterized in** that the steering input data further includes a desired relative thrust value defined by the degree of rotation from a central reference position (27) of the tracking-ball (16).

V79 P1SE/BRR
2001-11-15

ABSTRACT

Remote control system for a vehicle (1), comprising:

- a primary heading sensor (14) fixedly attached to the vehicle (1), said primary heading sensor (14) being adapted to detect a reference heading (N);
- a remote control unit (15) comprising a steering input manipulator (16), said remote control unit (15) being either portable by a user or rotationally attached to the vehicle (1) relative to a main axis (4) of the vehicle (1), the remote control unit (1) being adapted to communicate steering input data to
- a steering computer (12) programmed to process the steering input data into steering commands and to communicate the steering commands to a steering mechanism (9) of the vehicle (1),

wherein:

- said remote control unit (1) comprises a secondary heading sensor (19) which is synchronized with said primary heading sensor (14) with respect to said reference heading, and in
- said steering input data includes information of an active position of said steering input manipulator (16) relative to the reference heading (N), said active position of the steering input manipulator (16) determining the desired direction of travel of the vehicle (1) regardless of the orientation of the remote control unit (15) relative to the main axis (4) of the vehicle (1).

(fig. 2)

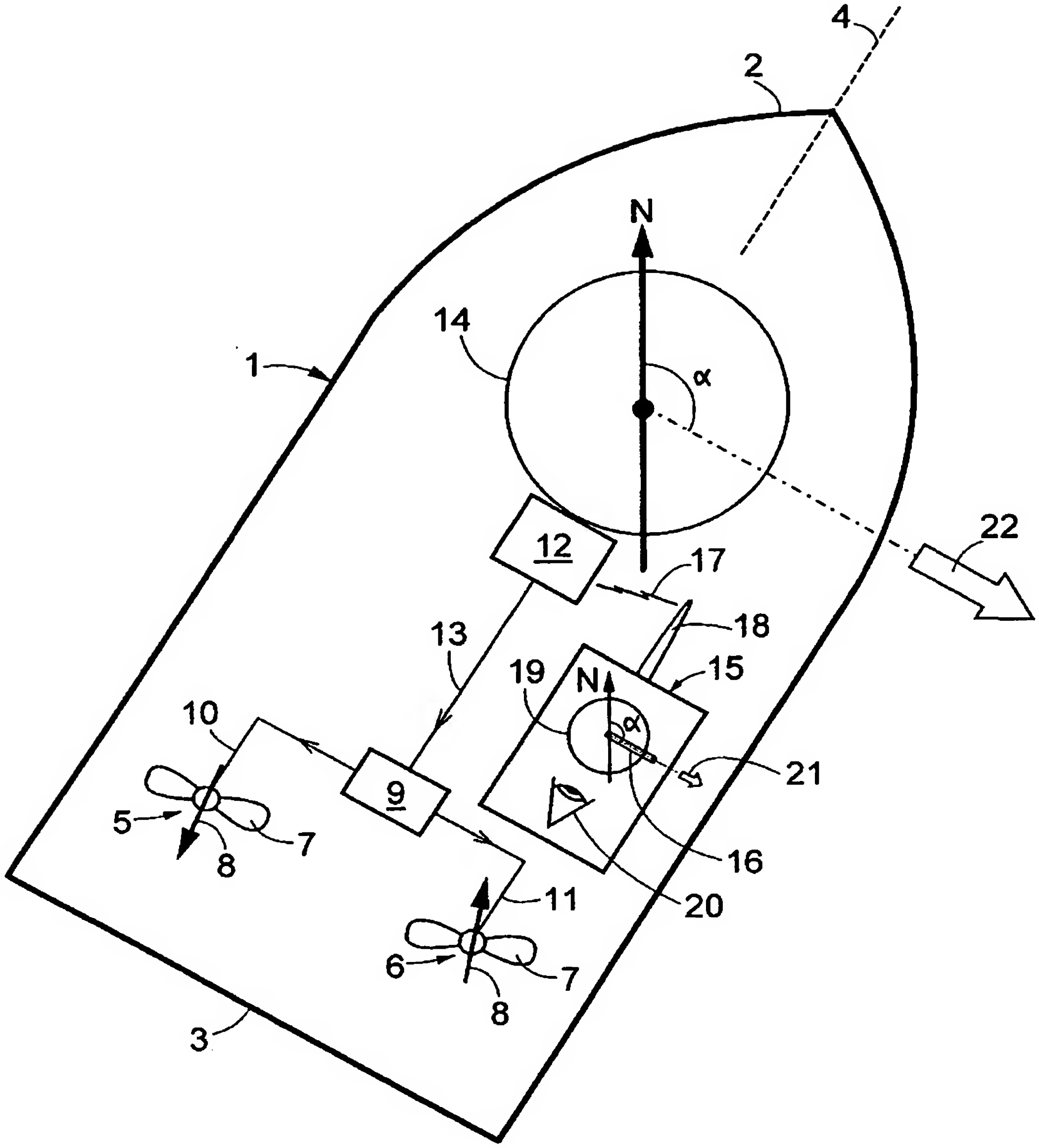

FIG. 1

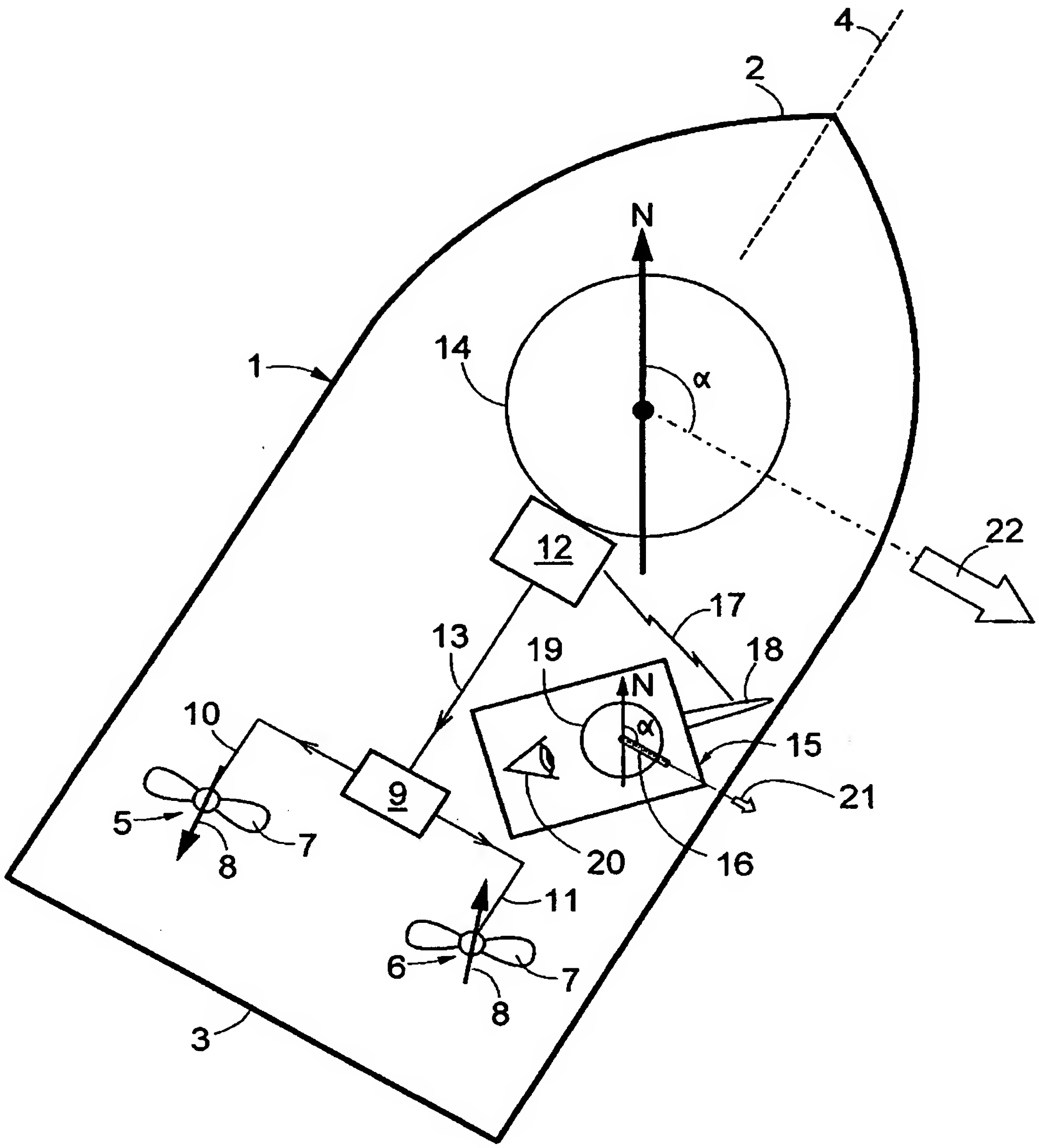

FIG. 2

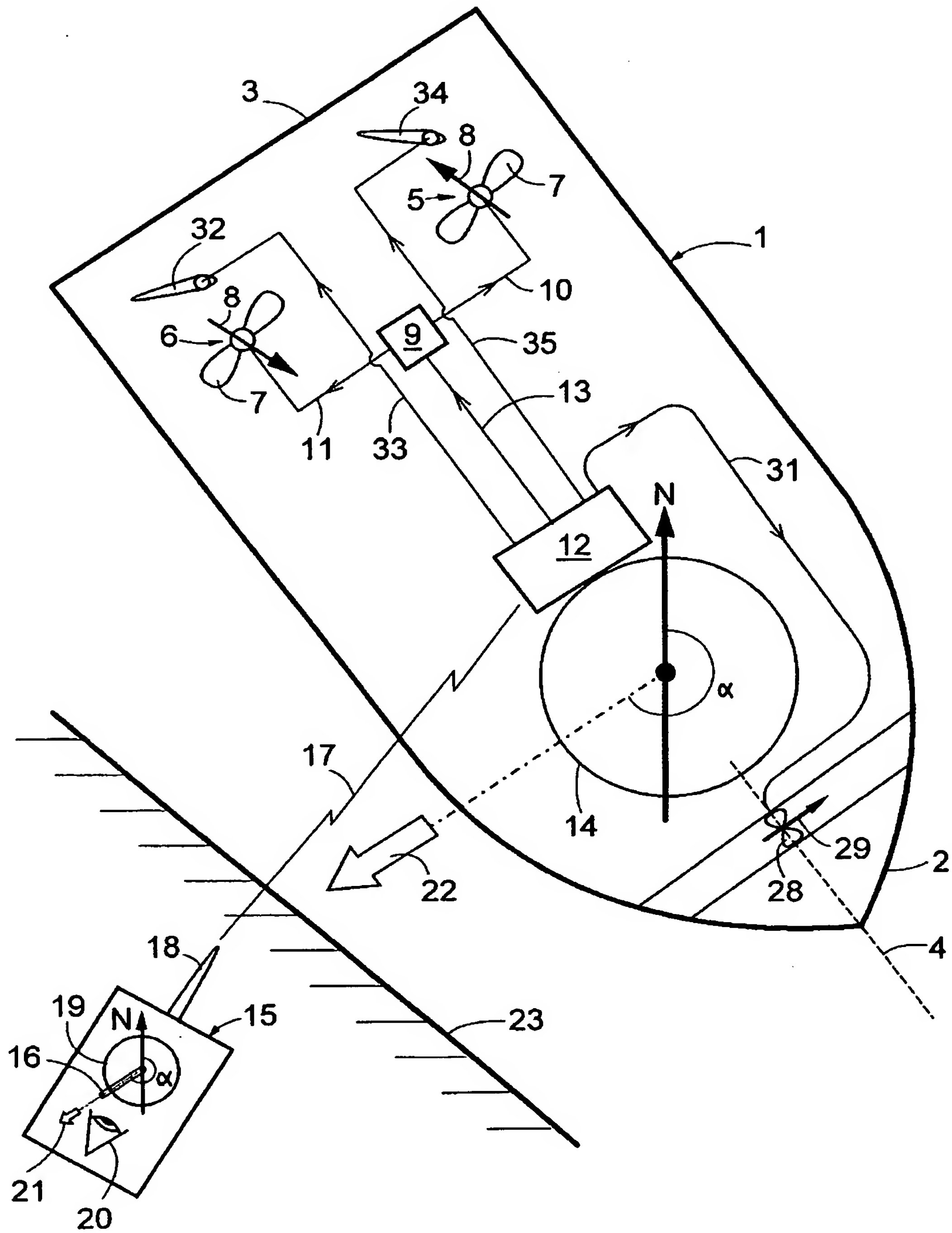
3
34
8
7
5
32
8
6
7
1
10
9
35
13
11
33
31
N
12
α
14
17
22
29
28
2
4
18
19
N
15
16
α
23
21
20

FIG. 3

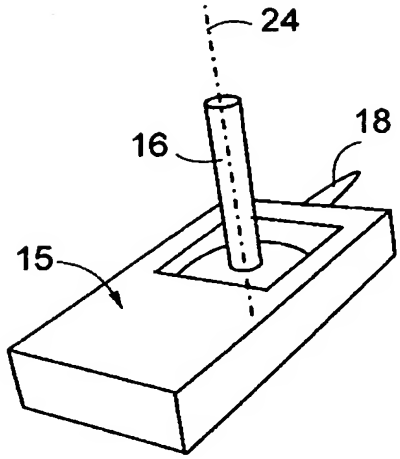

FIG. 4

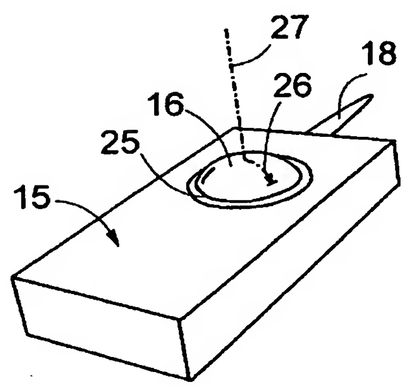

FIG. 5